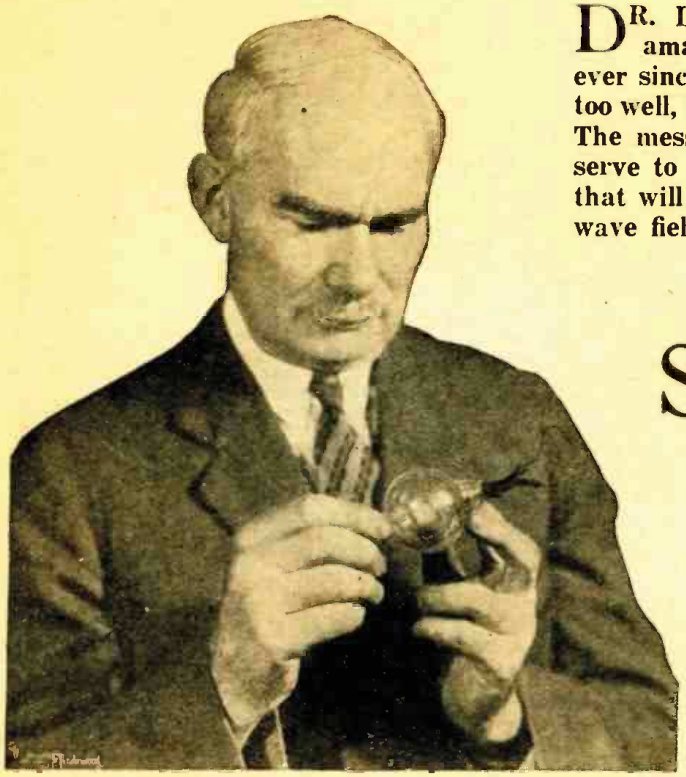

Dr. Lee de Forest examining an early type vacuum tube.

DR. LEE DE FOREST needs no introduction to the radio amateur. The famous inventor has been a radio amateur ever since the pioneer days, and as his present story shows only too well, he still has a soft spot in his heart for the radio amateur. The message which he gives the amateur in this issue should serve to inspire every short wave enthusiast. It is a message that will be long remembered by every true friend in the short wave field.

—Editor.

SHORT WAVE POSSIBILITIES *and* PROBABILITIES

By Lee de Forest, Ph.D.

THERE is nothing decidedly new about short waves. Strangely enough, the early experiments of Heinrich Hertz, who laid the theoretical groundwork for radio communication, were conducted with short waves and even ultra-short waves, which are now receiving considerable attention from advanced radio workers. In the archives of early radio history we come across many references to 5 and 10 centimeter waves—one-twentieth to one-tenth meter wave length. Hence our latest radio developments may be said to represent history repeating itself, but with the benefit of four decades of remarkable research, development and practical application as an invaluable guide.

How Short Is a Short Wave?

How short is a short wave? After all, this is purely a relative term. Compared with the work of Hertz and other pioneer experimenters, with their wave lengths of but a fraction of a meter, even our short waves below 5 meters would be considered relatively long waves. In terms of the early trans-oceanic radio experiments, our present broadcast band of 200 to 550 meters might be considered decidedly short waves. But in terms of our present radio art, wherein we cover the wave length spectrum from 5 meters or 59,960 kilocycles to well above 10,000 meters or 30 kilocycles, we consider anything below 200 meters, or 1,500 kilocycles, as short-wave radio. And below 5 meters, we refer to ultra-short waves.

It is well to take this opportunity of thanking the radio amateur for what he has done in the matter of short-wave developments, in addition to his other untold contributions to the radio science. Let us not forget that it was the radio amateur, forced to vacate the band now occupied to a large extent by radio broadcasters, who explored the possibilities below 200 meters. And as the radio amateur has been jostled along from one wave band to the next lower wave band, each time seemingly threatened with practical extinction, because of the unknown conditions existing in the virgin radio territory, he has gone ahead and blazed the trail so that others might follow. Usually the amateur's reward has been a "dispossess notice"! But when radio history comes to be written, a perpetual monument will be erected to him in many of the wave length bands, due to his wonderful pioneering efforts. Today, radio amateurs are making history on the 80-meter, 40-meter and 20-meter bands, and the more intrepid of their number are now exploring the uncertain region below 5 meters.

De-bunking Short Wave Radio

Due chiefly to the radio amateurs, short-wave radio has been de-bunked in late years to the point where the veriest layman can now enjoy short-wave thrills. We may recall the situation a few years ago, when short-wave radio was considered nothing short of black magic. Those desiring to invade this mystic territory were obliged to feel their way by the old cut-and-try method. Coils had to be individually wound for the purpose. Variable condensers were generally standard devices with some of the plates removed to reduce the capacity. The vacuum tubes had to be selected by the trial and error method, the bases removed and the terminals arranged in pig-tail fashion to reduce inter-capacity. Many a good tube, I fancy, was sacrificed on the altar of short-wave experimentation.

(*Continud on page* 79)

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Short Wave Possibilities and Probabilities

By LEE DE FOREST, Ph.D.

(*Continued from page* 10)

But little by little the radio amateurs succeeded in simplifying short-wave requirements. They learned how to make short-wave inductances, and the data was made available to the public at large. Condenser manufacturers, taking advantage of processes developed by amateurs, soon made the necessary low-capacity variable condensers. Standard vacuum tubes or audions, with their bases intact, became available for short-wave reception. And today, as a consequence, excellent short-wave receivers are available, permitting the layman to tune in the short-wave stations of the world without previous experience or undue patience.

The short waves hold the greatest thrills of radio just as the parachute jump from a burning plane is the greatest thrill of aviation. For short waves are the emergency waves of radio. Only a few years ago, we knew comparatively little about waves below 100 meters. We may even have questioned their practicability. We did not understand why a powerful short-wave transmitter could barely be heard at a distance of a few miles, yet came thundering in half-way round the world. We looked upon fading and swinging as jests of a Fate which could not be circumvented.

Today, short-wave radio is mastered to a large degree. Still, there is a thrill in having tamed the trickiest of radio technique. Based on mountains of data, we know precisely what frequency or wave length to employ for a given distance, time of day, and season. Indeed, we can practically make the skipping short wave land precisely where we will, which accounts for commonplace long-distance communication with ridiculously small power. No longer are we particularly thrilled with the 7½ watt transmitter, using an ordinary receiving set power tube, transmitting signals to the opposite side of the earth. With a given frequency and other perfected details, we almost expect such perform-

There Are THRILLS APLENTY on the SHORT-WAVES

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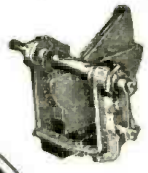

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ance. Swinging, or the wandering or wabbling of a signal from its determined frequency, is to a large measure overcome by the employment of rigid antenna systems at the transmitting end. Fading, the last remaining obstacle, is minimized by the use of multiple antennas, working on the good old rule of probabilities, as explained further on.

Europe and Asia Become Our "Neighbors"

The greatest thrill for the layman, however, is in the matter of distance and foreign radio tours. The usual layman, perhaps grows a bit blasé with the simplicity of the broadcast receiver tuned in to domestic stations, is certain to have thrills aplenty when the careful flip of the dial draws in England, Germany, Holland, Soviet Russia, Australia, India, Japan and other overseas countries now become radio neighbors. Frankly, short-wave radio is loaded with subject matter interest. It may be enjoyed by the layman who simply turns the dials, just as much as by the experimenter who is interested in the arrangement and re-arrangement, *ad infinitum*, of the components. While short-wave radio has heretofore been limited to the experimenter, due to the lack of knowledge and the unwillingness of radio set manufacturers to engage in what appeared to be a budding experiment, today many short-wave sets are available which insure positive results from the start.

What subject matter is interesting? One may ask. Well, various countries are now set up for an exchange of broadcast programs. The United States, for instance, has arrangements with British, German and Dutch radio interests, whereby our networks and independent stations operate supplementary short-wave transmitters, which fling the usual broadcast programs out into space, in return for which our overseas friends do likewise. For the present, most of the transmitters are approximately 5 to 50 kilowatts, most of them being no higher than 20 kilowatts. Although excellent results are being obtained even in the supreme test of rebroadcasting overseas programs, the power is yet too modest for consistent results. The writer firmly believes that once again the radio world has underestimated the task, as was the case in broadcasting, transoceanic and marine radio. Doubtless the power ratings will be increased several fold in the future, so as to establish more positive signals in distant lands.

However, it must be noted that the larger short-wave broadcasters are interested mainly in having their signals picked up by overseas broadcasters, fully equipped with the necessary facilities. In other words, they may not be particularly concerned with having the usual amateur or layman pick up the signals under trying conditions. Even so, before overseas broadcast features can be positively scheduled in advance, from one end of the year to the other, a notable increase in power will be required.

MAKING A LONG WAVE SHORT

Britannia May Rule the Waves—But the Radio Hams and S.W. P.H. Rule the Short Ones

MARCELLUS GERNSBACK, a New York S.W.P.H., who gets a short-wave fit when he doesn't receive Big Ben of London on G5SW daily, just fell heir to a soft graft. Camp Iroquois for Boys, Willetts Bay, Vermont. It invited him, ALL EXPENSES PAID for the summer, to catch short waves at the camp for the edification of the 60 odd boys. Let's hope the static treats him well.

The latest sport is this one, boys. We know several otherwise normal S.W.P.H. who now amuse themselves daily by listening to the transatlantic phone over short waves. They hear only the American side, therefore they listen in on a one-way conversation. Then they take it all down in shorthand. Next they try to fill in what the fellow over in Europe said. A cracked sort of a cross-word puzzle, we call it.

"Long may she wave" should be brought up-to-date with "May she short-wave."

What lay and amateur short-wave reception may come to is perhaps reflected in the work of the broadcasters themselves. Thus our American broadcast networks have the most elaborate short-wave receiving stations, located at the most advantageous points. Let us see just how the obstacles of good short-wave reception are eliminated.

Eliminating Short Wave Obstacles

First, there is background noise or inductive interference, which is particularly annoying in short-wave reception. Usually electric bells, telephone ringers, domestic appliances, sparking motors, and even automobile ignition systems prove somewhat troublesome. But the short-wave receiving station for rebroadcast purposes, is established at a remote location especially selected because of ideal reception conditions. The station is some distance away from the nearest highway, as well as from stores, shops and homes. Thus there is little or no opportunity for inductive interference, and a clean background is assured.

Second, there is the question of swinging, or frequency wobble. The short-wave transmitters are now arranged with rigid antenna systems, minimizing any such tendency of the signals.

Third, fading, the greatest obstacle facing the usual short-wave enthusiast, is overcome by what is known as "diversity reception." In other words, fading is not a universal phenomenon. A signal may fade at one particular location, only to be received with full volume a few hundred feet distant. Hence the broadcasters make use of several antennas, usually three, spaced about one thousand feet apart, yet connected to a common receiving equipment. By the law of probability, the signals are not apt to fade simultaneously at all three antennas, so that a good signal is possible from a collection of antennas. Also, several receivers are employed, connected with the collection of antennas. Each receiver may have an automatic volume control, which maintains the output at a given level. Lastly, the outputs of the several receivers pass through an automatic (vacuum tube) selector, which draws a varying signal quota from each receiver and strikes a predetermined uniform balance or level for the entire output.

Little wonder, therefore, that the broadcasters are in position to intercept, amplify, distribute and rebroadcast European programs over their networks with really good results, while the layman or radio amateur may barely hear the same programs direct. Yet as time goes on there is every indication that lay and amateur short-wave

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reception will be steadily improved, making use of the same general principles used by the re-broadcasters, though necessarily on a more modest scale. We are only in the infancy of short-wave radio reception.

Of course there are some who like to "talk" quite as well as "listen." In other words, there is transmission as well as reception. Transmission is more intricate than reception for the simple reason that it calls for an operator's license, as well as a station license. An amateur radio license may be readily obtained by the average person, after a short course of practice in code work. The thrills of reception are multiplied a thousand fold when one can transmit as well, thereby being at once audience and orator in the short-wave radio world.

As the writer views this question of short-wave radio, he notes a woeful lack of constructive literature in the past. Therefore, the appearance of this publication is most opportune at this time, when the public at large, depending more and more on usual broadcasting for certain program features, is necessarily seeking other means of satisfying the sporting instinct based on chance and uncertainty, as well as a means of self-expression through radio transmission. In short-wave radio, the public may well find the indoor sport which it seeks.

How to Build a 2 in 1 Receiver

By LOUIS B. SKLAR

(*Continued on page* 57)

14. .00015 Variable Condenser.
15. .00035 Variable Condenser.
16. 1st Audio Stage Socket.
17. 2nd Audio Stage Transformer.
18. Detector Stage R.F. Coil with Fixed Tickler.
19. 2nd Audio Stage Socket.
20. Loud Speaker Binding Posts.
21. Dial Illuminating Bulbs.
22. Battery Switch.
23. Dials.
24. Knobs.
25. First Audio Jack.
    Rheostat for Detector Tube.
    Set of Short-Wave Coils, Tubes, Batteries, Coupling, etc. Condenser Couplings, one insulating, and one metallic. (Hammarlund and Pilot are concerns making them.)

Using the '22 Tube

There will be little difficulty in adapting this circuit to the use of Type '22 tubes.

It will be necessary to shield the input circuit of the screen grid tube, to realize maximum amplification with the least regeneration. It was not necessary to shield the original receiver as it did not incorporate the screen grid tube.

Secondaries *S*1 and *S*2 will consist of a certain number of turns as determined by the capacity of the particular variable condensers used.

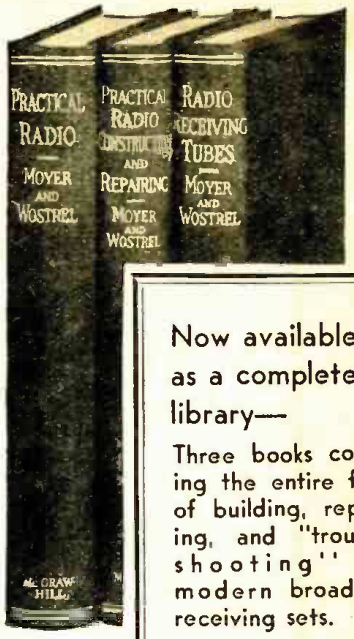
Primary *P*1 must be made with very small wire, as the coil must have very small dimensions. It is wound at the filament end of the secondary, as is primary *P*2. The number of turns in coil *P*1 is controlled by local reception conditions and the particular aerial used.

Primary *P*2 is also wound with very fine wire and contains about one-third the number of turns on the secondary.

It is to be noted that the filament resistance indicated as *R*, must be about 10 to 15 ohms. Additional resistance may be cut into the positive "A" lead to reduce the "A" voltage at the tube filament to the required value. The necessity for having a certain resistance value for *R* is the "C" bias requirement of the tube; resistance *R* supplies this and a special battery for the purpose is not needed.

Condenser *C* may have a value of about one-quarter microfarad.

For satisfactory short-wave reception it will be necessary to arrange the aerial so that it does not swing badly, or the result will be pronounced fading and swinging of signals. Fading is a rise and fall in volume, at one wave length, compensated by variation of the volume control.—(*Courtesy Radio-Craft.*)



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